SCIENCE

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FRIDAY, AUGUST 18, 1899.

CONTENTS:

Daniel G. Brinton, with Plate: W J M..... 193

Presidential Address before the Society for the Promotion of Engineering Education: PRESIDENT T. C. MENDENHALL..... 196

Work of the U. S. Geological Survey: BAILEY WILLIS..... 203

Scientific Books:—

Poincaré's Cours de physique mathématique: R. S. W. *Newsholme's Elements of Vital Statistics:* WALTER F. WILLCOX. *Books received*..... 213

Societies and Academies:—

Section A, Mathematics and Astronomy, and Section G, Botany of the American Association for the Advancement of Science..... 217

Discussion and Correspondence:—

The Foehn Winds of Switzerland: PROFESSOR CHARLES BUNDY WILSON. *The opening of the Mouth as Expression:* HIRAM M. STANLEY 218

Astronomical Notes:

Observatory of Yale University; Flower Observatory of the University of Pennsylvania; Chamberlin Observatory of the University of Denver; Astronomical Objectives: PROFESSOR WINSLOW UPTON..... 219

Notes on Physics: F. C. C..... 220

Notes on Inorganic Chemistry: J. L. H..... 221

Scientific Notes and News..... 222

University and Educational News..... 224

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DANIEL G. BRINTON.

IN the death of Dr. Brinton American science has suffered a grievous loss. Notably brilliant and versatile, endowed with exceptional acumen, and an indefatigable worker, he investigated much of the broad field of anthropology with signal success; a fluent and forceful speaker and a clear and cogent writer, he was remarkably successful in putting the results of his work before general auditors and readers as well as students; exceptionally public-spirited and appreciative of the normal human demand for better knowledge, he strove constantly to extend and improve instrumentalities for the diffusion of science. Thus through rich natural endowment, coupled with wise and persistent effort, he materially advanced the Science of Man and placed himself in the front rank of the anthropologists of the world. His activity continued undiminished (despite the weight of well-guarded suffering consequent on military service) until checked by the illness which terminated with his life.

Born in Chester county, Pennsylvania, May 13, 1837, Daniel Garrison Brinton graduated from Yale (A.B.) in 1858, and from Jefferson Medical College (M.D.) in 1861, and assimilated his thorough training during a year in Europe, with special studies in Paris and Heidelberg. Stimulated by the martial spirit of the time, he then returned and entered the Federal army as

acting assistant surgeon. His energy and trained skill were quickly felt in the medical department of the army, and he was rapidly promoted; commissioned as surgeon within six months after enlistment, he was soon after made surgeon-in-chief of his division, and was appointed medical director of his corps fifteen months after entering the service. During this period he participated in several notable engagements. In consequence of the severe strain attending the battle of Gettysburg, he suffered a sunstroke, which compelled his retirement from field duty, and from which, in his own judgment, he never completely recovered. He resumed service, however, as superintendent of army hospitals at Quincy and Springfield, Illinois; and, on the close of the war in 1865, he was brevetted lieutenant-colonel and honorably discharged. Returning to Philadelphia, he became, in 1867, editor of the *Medical and Surgical Reporter*, a position retained (always in connection with other work) for twenty years; he was also editor of the *Compendium of Medical Science*, and, in 1885, edited and made important contributions to one of the volumes of the 'Iconographic Encyclopædia.' In 1882 he began editing and publishing the 'Library of American Aboriginal Literature,' one of the notable scientific enterprises of the country. In 1884 he was made professor of ethnology and archæology in the Academy of Natural Sciences in Philadelphia, and in 1886 professor of American linguistics and archæology in the University of Pennsylvania. For some years he was President of the Numismatic and Antiquarian Society of Philadelphia; and in 1886 he was Vice-President and in 1894 President of the American Association for the Advancement of Science, filling these positions with great ability and dignity.

Dr. Brinton's literary contributions to American anthropology in its various aspects have been many and important. His bent toward the science began in early manhood; spending the winter of 1856–7 in Florida, he yielded to the excellent opportunity for archæologic and ethnologic work. Some of the results of his operations were incorporated in 'The Floridian Peninsula, its Literary History, Indian Tribes, and Antiquities,' 1859. With the return to civil life and opportunity for original study in 1865 the early impressions were revived and led to researches concerning the symbolism represented in the prehistoric relics and surviving among the aboriginal tribes, and the fruits of these researches saw the light in 'The Myths of the New World, a Treatise on the Symbolism and Mythology of the Red Race of America,' published in 1868, and in revised edition in 1876. Various minor publications followed, marking the progress of studies constantly increasing in breadth and depth, notably the 'Essays of an Americanist,' 1870, and 'American Hero Myths, a Study of the Native Religions of the Western Continent,' 1882; and in 1876 the impulse awakened by the Floridian symbolism found further expression in 'The Religious Sentiment, a Contribution to the Science and Philosophy of Religions.' Meantime the confinement and restriction of field work imposed by editorial duty, combined with growing mental activity, led him to seek original sources of information in the languages and recorded traditions of the native tribes. Various contributions to aboriginal philology resulted, and the impulse in this direction found full expression in the six volumes of 'Brinton's Library of Aboriginal American Literature,' 1882–1885. As his field extended his grasp strengthened, and comparisons of the Amerindian and other peoples were made with great acumen and comprehensiveness, as shown by his succeeding works: 'Races and Peoples,' 1890, and 'The American Race,' 1892; these being among America's most important contributions to anthro-

pology. Taught by professorial work to adopt diverse methods of exposition in order to reach wider circles, some of his results were dressed in literary or even dramatic form, like 'The Pursuit of Happiness,' 1894, and 'Maria Candelaria, An Historical Drama from American Aboriginal Life,' 1897; yet it was appropriately prophetic of the final rounding-out of his life work that a recent publication should be a review of the researches of two score years into the motives of primitive symbolism and a summary of his scientific studies, under the title 'Religions of Primitive Peoples,' 1897—his latest, and in many respects, his greatest contribution to the literature of science.

Largely by reason of his versatility, it is not easy to define Dr. Brinton's original additions to the body of increasingly definite knowledge comprehended under the term anthropology; his range was broad, and his touch vivified many lines of thought. Perhaps his richest gift to scientific method was that embodied in his unique library, designed "to put within reach of scholars authentic materials for the study of the languages and culture of the native races of America;" perhaps his richest contribution to the body of science is the second chapter of his 'Religions,' entitled 'Origin and Contents of Primitive Religions,' which has well been characterized as a work of genius; while certainly the influence of his eloquent advocacy of the doctrine of mental unity will long remain in the minds of the anthropologists of the world. Yet despite the difficulty of signalizing special features of well-rounded work, the great fact remains that Brinton's investigations and expositions have served to set forward the outposts of the Science of Man along almost the entire front.

During the last two decades workers in various branches of science have benefited much by Dr. Brinton's readiness to promote and diffuse knowledge by all means at his command; he conducted a large and varied correspondence in which he freely gave of his information to numberless seekers; he contributed voluminously to current periodical literature, both special and general; he was given to attending scientific meetings, and was particularly free in formal and informal communications and discussions; and he was a frequent and attractive lecturer. He was no less generous in editorial work; his name has added strength to the editorial corps and his pen has added interest to the pages of SCIENCE since the beginning of the present series in 1894; he was one of the original editors of the *American Anthropologist* (new series), and at various times he had editorial connection with other journals of scientific character.

Among scientific associates Dr. Brinton was noted for courtesy and urbanity even more than for the vigor and insistence whereby his convictions were enforced. Clear and trenchant in statement, clever and terse in debate, incisive and even sharp in criticism he was instinctively fair and tolerant; and no forceful thinker was ever readier to recognize the right of free opinion. These and other qualities united to form a strong personality, which served the world well in attracting auditors and pupils toward useful lines of thought.

It was among intimates that Dr. Brinton was seen at his best. Of refined social sense and of peculiar delicacy in word and manner, an easy and often brilliant conversationalist, and a pleasing raconteur, he was a delightful companion, charming host, or ideal guest, as occasion demanded. Naturally his associations warmed into friendships, many and deep; and the passing of his life has rent unnumbered ties and wrought widespread sorrow.

Surviving more than three-score years despite an infirmity of war concealed with

Spartan care, and living a remarkably busy life, it is but natural that Dr. Brinton should become a prominent figure of his times. His death creates a void that must long be felt; yet few American scientists have left worthier monuments in the form of finished works.* W J M.

PRESIDENTIAL ADDRESS BEFORE THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.†

The presidency of a Society which embraces in its membership representatives of all the leading schools of engineering and applied science in this country is an honor which one may not lihgtly accept or indifferently bear. Although not established by its organic law, its traditions make it the duty of the presiding officer to present an address which should be, in spirit, at least, worthy of so important an occasion. Happily for those upon whom this honor may fall, custom has not yet restricted or defined the sphere of discussion which shall be thought suitable for such a paper; on the contrary, one may properly take advantage of this opportunity to become temporarily a *ronin*, a free lance, attacking everything and everybody, seeking only to give full and fair exposition of one's own personal, and, may be, peculiar views. This is the one compensation going with the burden which the Society insists must accompany the honors which it bestows. No apology is needed, therefore, for the selection of a topic the consideration of which may seem more or less irrelevant and unnecessary to some and, perhaps, unwelcome to others. In the present instance the choice is due to a strong conviction that schools of engineering are, for the most part, far from doing their full duty in an important matter, namely, the inculcation and dissemination of sound views, both theoretical and practical, relating to scientific metrology.

We cannot ignore the fact that the general public, even the intelligent public, receives its information regarding scientific and technical questions almost entirely from daily newspapers and popular magazines, than which, we will all admit, there could hardly be a more untrustworthy source. The widespread taste for sensationalism by which we are now cursed, a taste which seems to grow with the efforts made to satisfy it, offers a premium upon anything startling or revolutionary, giving little heed to sober, every-day truth. If one-tenth of the wonderful scientific discoveries that have been announced with glaring headlines in the public press within the last five years had *actually been made* it would, indeed, have been an epoch-making period; but, fortunately for everybody, they existed mostly in the brilliant imagination of the space writers who alone were benefited by their publication. If this were all we could afford to be indifferent, but there is the further disagreeable fact that a large number of intelligent people are led to look upon this sort of thing as real science, and few of us have an adequate conception of the extent of this delusion. One of the results is that in science, as in many other things, those who do the real work of the world fail to be credited with it, while the people are lavish in their praise of those whom they *believe* to be worthy. Only a few weeks since I found in an article on teaching history, written by the superintendent of schools in a large city, the names of a quartet of Americans most distinguished in war and peace. Three of the four were Washington, Lincoln and Franklin. As this is not meant to be a humorous paper, I will not mention the fourth, contenting myself with saying that in this instance the newspaper had done its work well.

*The portrait published as frontispiece is from a photograph taken in April, 1898, by F. Gutekunst, Philadelphia.

†Given at the Annual Meeting, Columbus, Ohio, August 17, 1899.

A curious and, in my judgment, a seriously instructive example of the readiness with which people accept newspaper science is found in the attempt made a year or two ago to fix the value of the ratio of the circumference to the diameter of a circle by legislative enactment. This incident may be familiar to some of you, but it is entirely worthy of consideration by those to whom is entrusted a large share of the instruction in exact science in American colleges. The legislative body involved was not one of a State south of Mason and Dixon's line nor west of the Mississippi River. It was a body chosen by the people of one of the greater States of the Union—one deservedly enjoying considerable distinction, especially in literary circles, on account of the eminent men it has produced, and also for the excellence of its educational institutions. In this Legislature, House, Bill No. 246 was entitled 'A Bill for an Act introducing a New Mathematical Truth,' * * * which truth, in the second section of said bill, turns out to be that the circumference of a circle is just $3\frac{1}{5}$ times its diameter. In the capital of the State is published a daily morning paper of unusual excellence. Not generally given to sensationalism, its contents are usually clean and wholesome, its news well collected and arranged, and even a single copy gives the impression that it is an example of the better phases of journalism. Yet this paper devoted more than two columns of its first page to an exploitation of this most important discovery, which had been made by a physician living in an obscure corner of the State. It was announced that the laws of the quadrature had been copyrighted and that this newspaper was allowed to be the first to make them public, this privilege being, without doubt, the bait which caught the uninformed editor. Some measure of his credulity may be found in his sober declaration that the circle-squarer's demonstration had been accepted by all eminent mathematicians; that the *American Mathematical Journal*, the highest authority in the country, had hastened to publish it, and this publication instantly attracted the attention of the scientific journals in Paris, the editors of which had eagerly sought contributions from the author of the discovery. The solution had been copyrighted in the United States and in England, Germany, Belgium, France, Austria, Italy and Spain. At Washington it had won the support of the professors of the National Astronomical Observatory, Professor Asaph Hall, 'whose fame was secure with the discovery of the moons of Mars' being specially delighted with it and finding in it a complete explanation of a hitherto unexplainable anomaly in the earth's motion. The desk of the discoverer was full of letters from leading mathematicians in Europe and America, and one from his agent in London proved that his demonstration had been shown to Tyndall and Huxley, who warmly endorsed its accuracy. Professors in Ann Arbor and from Johns Hopkins University had seen the demonstration and declared it perfect. I leave to the guardians of the name and fame of these institutions, and to others referred to, the task of ascertaining just what lineal descendant of Ananias was at that time on the editorial staff of this journal, but the actual disposition of the bill by the legislative body is a matter of much interest. When introduced, it was taken humorously by the Speaker of the House, who happened to be a graduate of a widely known educational institution, and he ordered its reference to the Committee on Swamp Lands. Two days later, however, the great discoverer had a hearing before the State Superintendent of Public Schools and the Committee on Education, who at once endorsed the solution; the Committee on Canals and Swamp Lands

reported House Bill No. 246 back, with a recommendation that it be referred to the Committee on Education; the latter Committee gave the bill careful consideration and reported 'the same back to the House, with the recommendation that the said bill do pass;' the bill was called up by the Committee and, *mirabile dictu*, the bill actually passed that branch of the Legislature, by what was reported to be a good, safe majority. Before it actually became a law, however, its character began to be recognized and its further progress was arrested. The possibility of such an incident at the very end of the nineteenth century is a fact from which some useful inferences may be drawn, and a just allotment of responsibility might well cause some anxiety.

But it is not to the particular kind of metrological reform suggested by this incident that I desire to ask your special attention. Josephus says that Cain 'broke the tranquility of the world by introducing weights and measures,' and it is perhaps not without significance that the first exponent of precise measurement was also the first homicide. At any rate, it will not be denied that the welfare of mankind has been enormously affected by the development of the art of weighing and measuring, and the importance of this art has grown with the perfection and complication of enlightened society. The systems of metrology in general use among English-speaking people at the present time have come to us from remote, almost pre-historic time, through Greece and Rome, and thousands of years have passed without any marked improvement in them, except in the betterment of fundamental standards, the interrelation of which is still as essentially illogical and unscientific as in the beginning.

As every one knows, the nineteenth century has witnessed a marvelous metrological reform among nearly all other races, and it is of this reform, never so important to us as just now, that I propose to speak. I am glad to assume in the beginning that you are all quite familiar with the general facts relating to this controversy, and I ask your consideration of the subject, not because of any lack of knowledge on your part, but rather because of my belief, already expressed, that you and the work you stand for have failed in a large measure, perhaps for lack of interest, in the active dissemination, among the general public, of the principles and advantages of a reformation of vital consequence to their material interests.

A brief review of existing conditions will be of use to those who have not given the subject serious thought. It is not generally known that the legal, fundamental standards of length and mass in this country are as numerous as the States of the Union. It will not do to say that these are identical, for they are not and cannot be, and many of their derivatives are decidedly different. There is a widespread notion that there is a United States standard pound which is everywhere legal, and a yard of the same authoritative origin, but this is an error, for these are only legal in transactions to which the general government is a party, and then only by authority of the Secretary of the Treasury. There is but one commodity which must everywhere be measured by one standard, and that is the coinage. And even this is nominally, not actually, referred to a material standard, legalized over seventy years ago, which is obsolete in form and construction, 'without pride of ancestry or (let us be thankful) hope of posterity.' Practically we ignore all legislation in the matter of fundamentals and universally accept standards of mass and length from two or three prominent makers who have mostly adopted those of the U. S. Office of Weights and Measures. There is much local legislation, however, on derived measures and much confusion results

therefrom. As an example, an act passed by the State of Massachusetts only five years ago may be cited. It legalizes *twenty-six* different bushels in one section, while in another it declares that a bushel *in heap measure* shall contain 2150.42 cubic inches, this being the volume of the well-known Winchester bushel when flat or struck, as used by the U. S. government and almost everywhere in this country. It also legalizes a dry gallon of 282 cubic inches, together with the liquid gallon of 231 cubic inches, which the government uses, thus creating an absolutely unnecessary but extremely annoying confusion. In one State there is a law that innkeepers "shall sell beer and ale by wine measure to all persons as drink it in their houses and by beer measure to all persons as carry the same out of their houses"; in another, and this in New England, it was enacted comparatively recently that in measuring certain commodities "one bushel and three quarters of a peck shall be deemed a bushel." In spite of legislation in many States fixing the value of a barrel at $31\frac{1}{2}$ gallons, it contains in these same States almost invariably 40 or 42 gallons. In one State a gallon of milk must contain 231 cubic inches; in another its capacity is fixed at 282 cubic inches. Not only is the value of a bushel when determined by weight different for different commodities, but for the same commodity there is great variation among different States of the Union, amounting, in many instances, to fifty and seventy-five per cent. I need not consume your time in relating the many other inconsistencies and absurdities inherent in our present system, such as the variety of meanings attached to the word *ton*, not less than three or four in number; the confusion of pounds, ounces, etc.; the elusive and uncertain meaning of *perch*. With all of these and many others you are already familiar, and the whole system is so fearfully and wonderfully made that it may be safely affirmed that no man lives who knows and understands all of it.

Nor is it necessary for me to consider the origin and nature of the system which those interested in metrological reform wish to see installed in its place. Most, if not all, of you know it very well and have been accustomed to make use of it in a greater or less degree. The innumerable advantages of a system of metrology as simple and as scientific as that known as the metric system are now all but universally admitted. They have been written about and talked about and learned by actual use to such an extent that a presentation of them here would be a waste of time. I prefer to briefly consider a few of the more important arguments that have been made against this system or against its use in this country. There is a certain class of objectors, small in number, quite unworthy of serious consideration. Among them are those who see something sacred in the yard and the pound, because they are relics of antiquity, and something inherently wicked in the metre and the kilogramme because they originated with the French during the Revolution at the close of the last century. To some of them the very mention of the metric system is like a red flag to an anarchist, and two or three of them have published elaborate but tiresome arguments against the proposed reform, abounding in inaccurate statements and illogical and unscientific propositions. They mostly reveal a condition of intellectual atrophy over which it is but common charity to draw the veil of silence. There are, however, some criticisms of the metric system that are entitled to the most serious consideration on the part of its friends, and some of them are urged by those who would gladly welcome metrological reform if it came in a way which met their approval. The advocates of the metric system not only do not wish to

avoid rational criticism, but they heartily desire it, believing that the more widely it is known and discussed, the more its advantages are understood, the more enthusiastic supportors it will have.

One of the commonest arguments against it, one well known to all of you, I am sure, is that it is decimal and not duo-decimal or binary, or based upon some devisor other than ten. One may admit, for the sake of argument, that there would be advantage in subdividing a unit by continual bisections, but the extremely limited area to which this advantage would be restricted is almost universally overlooked. It is forgotten that it is only when measurements are the result of estimation or judgment that this superiority would be felt. This being admitted, it further follows that the exercise of judgment, wherein bisection may possess an advantage, occurs only when a single undivided unit is under consideration, and who will claim for a single instant that the difficulty of estimating a fraction of a unit is in the least dependent on whether that unit is itself the tenth or the eighth or the twelfth of another. The plain fact is that if one is contemplating the metre as a unit it is just as easy to think of or set off a half, quarter or eighth or sixteenth part as if it were a yard, and the same is true of the decimetre or centimetre when compared with the foot or inch. Indeed, one who is accustomed to use the metric system speaks and thinks of a half or quarter centimetre or a half or quarter millimetre without the slightest embarrassment, never imagining that he is in the least inconsistent or 'disloyal' to the decimal system. It is curious that this objection should be urged by people who have long ago become accustomed to a like condition of things in their currency and who would be extremely unwilling to go back to a system non-decimal in character. No one will pretend that the sub-division of a dollar offers any inconvenience and every one knows that the superiority of the decimal system in currency is so manifest that nearly all nations have adopted it in one form or another. Whatever disadvantages might be anticipated in the use of the dollar or the metre with decimal sub-divisions are involuntarily destroyed by the natural tendency to refer to smaller units rather than to continuous bisections. Thus we may talk of a half metre, or a quarter metre, but for smaller quantities the decimetre or the centimetre are at once chosen, and when we wish to go below a half of a cetimetre the millimetre offers itself as a convenient unit. In the same way we find no embarrassment in taking up the cent as a unit when it is desired to go below a quarter of a dollar. That the several units thus used are decimally related to each other is the one fact that makes all of this beautiful simplicity possible. I have ventured to elaborate somewhat on this point because many people are of the opinion that the fact that the radix is ten and not two is a really serious objection to the metric system. It is believed, however, that careful study of the principles involved, following the lines indicated above, will show that this fact is of no importance. And it must not be forgotten that our present system is anything but binary and that the adoption of almost any radix would be an enormous improvement. But, above all of this, it must be remembered that nobody claims any special virtue or unique qualities for the number *ten*. It is not because it is decimal that the metric system is so far superior to all others. The superiority rests upon two great facts, the first of which is that the radix of the system is identical with that of the system of notation and numeration now and for many years in use by all civilized people. It may well be that a binary or duodecimal or some other system of notation would offer advantages over that which has prob-

ably fixed itself upon us for an indefinite future, but it is absurd to argue that metrological form must wait upon a notational revolution. The probability of the latter is almost infinitely small, at least for centuries to come, while already a majority of civilized nations have adopted the decimal system of weights and measures. The other great fact on which the superiority of that system depends is the beautifully simple inter-relation of units, resting upon constant physical properties of matter. No other system is for a moment comparable with it in this respect, and this alone would entitle it to consideration and adoption by all progressive communities. I pass over many more or less trivial objections to the metric system, all of which have been successfully answered many times, to take up one which is of far greater importance than all others, although it is not really a fault in the system itself. It is urged that the adoption of the system in this country must be accompanied by very large loss, especially among machinists and manufacturers, of accumulated material in the form of tools, machines, patterns, etc., which have been designed and made upon a basis of the foot or inch unit of length and which would be rendered useless by the introduction of the metre or centimetre. It is also argued that there would be great loss occasioned by the disuse of scales, balances, weights, etc., which would necessarily be replaced by metric measures. On these grounds several very able engineers have based a strenuous opposition to the proposed reform, and their influence is freely admitted to be the most serious obstacle to its progress.

Against this argument a few incontrovertable facts are put. One of these is that only a relatively small proportion of tools and machines are in any way effected by the question of standards; another is that the life of a tool or machine in these days is comparatively short, not only on account of deterioration from use, but as well because of continual improvements which render designs only a few years old practically worthless. Much has been said about the enormous value of patterns for machinery and machine tools which have accumulated during a period of years and which would be rendered useless by the introduction of new standards. Concerning this it may be said that in many of the most extensive manufacturing establishments in this country patterns once used are not considered as assets at all, the chances being that, through the rapid improvement in design constantly going on, they will shortly become obsolete. There is also the further fact, testified to by some important establishments in which the metric system has already replaced the old, that there is almost invariably enough to spare in a casting which is to be machine finished to make it possible to work it to metric dimensions. In a similar way the possible cost of the reform due to the necessary change in apparatus and standards for weighing and measuring has been grossly overestimated. Balances will be, of course, not affected at all; platform and other scales can readily and cheaply be adapted to the new units. Those who have maintained a somewhat bitter opposition, based on this question of cost, to all suggested legislation looking to metrological reform, seem to have ignored two important considerations; the first is that the thing which they proclaim to be so difficult that it is practically impossible has already been accomplished and many times, by different European nations with almost no difficulty and under conditions vastly less favorable than those existing with us. The second is that no reasonable advocate of the metric system expects the transformation to be made in a night or in a month or a year. The history of the adoption of

our currency system furnishes a useful example of what may be expected. More than a generation elapsed after it became the legal system of the nation before its use was even approximately universal.

There is another objection to the metric system important enough to deserve examination, and that is the alleged difficulty of understanding it and of becoming accustomed to its use, and it has been affirmed that this difficulty would be especially marked among mechanics and workmen of all classes who make frequent use of weights and measures. Here, again, we may best appeal to experience. To Germany, Austria, Italy, Spain and other European nations outside of France the metric system came as a foreign innovation, but nowhere was any serious difficulty experienced. The same may be said of practically every nation on the American continent, excepting the United States and Canada. Before a Parliamentary Committee, Siemens testified concerning its introduction in his own works in Germany, that "it was all a matter of about a fortnight or three weeks; then the people were accustomed to it and did not ask for any more of the old measures, but asked for the new." In Germany the Adopting Act was passed in 1868, and the use of metric measures was made compulsory in 1872. Siemens testified that this actual adoption took place mostly between January 12, 1870, and January 1, 1872, and that when the compulsory time came there was nobody to be compelled. Other German testimony was of the same character, that knowing they had to be ready when the time came they were ready before the time came. Professor Foerster, Chief of the German Bureau of Weights and Measures, under whose direction the introduction of the metric system was made, has furnished us a most interesting account of how it took place. In speaking of the complaint, then common in Germany, as it has been here, that the metre was too long, that "we can estimate by the foot and not by the metre," he makes the very suggestive remark that "experience has shown that here too many people have only hung a cloak around habit in order to hide its nakedness." You are doubtless all aware that a few years ago in the great English engineering establishment of Willans & Robinson the metric system was adopted to the entire exclusion of British measure. Their testimony is strongly in its favor and shows that English workmen very quickly adapt themselves to its use, and when once they understood it all agreed that it was much easier to work to than the English system. The head of their tool room testified that "it was a little awkward for a time," but this lasted only about two days. Some of our own large manufacturing establishments having branches in Europe, such as the General Electric Company, have declared that they found a decided advantage in making and working to metric drawings. Indeed, there is an 'embarassment of riches' in testimony of this kind, and I feel that I ought rather to apologize for bringing any of it before this body. We may justly regard the case as proven and the controversy closed, except as to the question of ways and means. If it be affirmed that there is no demand for the change I could deluge the Society with resolutions of chambers of commerce, boards of trade, manufacturers' associations, engineers' clubs and societies, builders' exchanges, architects' clubs, pharmaceutical associations, trades unions, educational and scientific bodies and other public organizations too numerous to even name. In England the past five years have witnessed what is little short of a revolution of sentiment on this question, the result of an agitation originating not among scientific men, but with the so-called practical people. It is there, as it must soon be here, a question

of vital importance to commerce and trade. The testimony of their far-sighted consular agents in various parts of the world is that British trade with all nations except our own is sadly handicapped by its units of measure, and our own consular reports are of the same tenor. Within a year we have entered upon a new era in our foreign relations. Our trade with foreign nations has increased enormously and must increase still further if we are to maintain our footing. We have already absorbed a considerable population by whom the metric system has long been used, and our merchants and manufacturers are already feeling the disadvantages of our antique and irrational measures of quantity. Fortunately for us, our principal competitors are the English, who are carrying nearly the same burden. But they have been quick to recognize the necessity for reform and in five years they have made more progress towards it than we have in thirty.

Schools of engineering and professors of engineering and applied science can do more, if they are so minded, to help their country in this emergency than any other agency that I know of. They can do it by a more liberal use of the metric system in their daily work. Electrical engineering, by a wonderful stroke of good fortune, emancipated itself from this curious slavery in the very beginning, and its astonishingly rapid growth from infancy to the vigorous manhood which it now enjoys is very largely due to that fact. In the engineering college of to-day the student in physics and chemistry is brought into close relations with the metric system, but when he advances to his professional studies in civil and mechanical engineering he is too often compelled to relapse into the exclusive use of the foot, the pound and the gallon. I am far from recommending the abandonment, at this time, of these useful units, but I strongly urge the importance of allowing them to share their work with their metric analogues and very liberally. Even if there were no other advantage there would be an enormous gain to the student in compelling him to do his problems and his laboratory exercises in more than one system of units, than which nothing contributes more to clearness of understanding and soundness of knowledge. If we had begun this a quarter of a century ago and kept it up we should be in much less danger of being beaten in the race for the markets of the world than we are to-day; for this system is bound to become universal and in the near future. The prodigious advantages which it offers in its simplicity, its economy and its already extensive use will insure this. No body of men can more effectively influence public sentiment to an appreciation of this fact than those I now address.

One of the ablest and most scholarly arguments in favor of the metric system ever made was that of Charles Sumner in the Senate of the United States more than thirty years ago. He summarized the argument as follows: "A system of weights and measures born of philosophy rather than chance is what we now seek. To this end old systems must be abandoned. A chance system cannot be universal. Science is universal; therefore, what is produced by science may find a home everywhere."

T. C. MENDENHALL.

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*WORK OF THE U. S. GEOLOGICAL SURVEY.**

APPROPRIATIONS for the work of the U. S. Geological Survey for the current fiscal year amount to $806,000 as against $816,000 for the preceding fiscal year. The apparent decrease is largely because of special items appropriated in the former year, one of which, for printing and binding monographs, amounted to $40,000. The amounts for

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actual field work and office compilation thereof are, in fact, increased. In the two items of topographic surveys in general and topographic surveys of forest reserves there is an increase of $40,000 over 1898–99, and $10,000 was added to the amount for collecting and publishing statistics of mineral resources. A special appropriation for surveys in Alaska carries $25,000, a sum the same as was available last year.

Topographic Branch.—The increase in the appropriations for topographic surveys resulted from the demands of Eastern States that cooperative surveys should proceed more rapidly. Cooperative surveys are now in progress with New York, Pennsylvania, Maryland, Maine and Alabama. The total sum of appropriations by these States for cooperation amounts to $48,500. The Geological Survey is pledged to expend in each of these States an amount equal to that appropriated by it, and a State Commission or its representative determines the order of procedure of surveys; the work in New York, for example, is directed chiefly to surveys of the areas of water supply for the Erie Canal and the Hudson River, whereas in Pennsylvania stress is laid upon the importance of topographic maps to serve as bases for detailed geologic surveys of the coal, oil and gas regions. In Maryland the topographic work is distributed according to needs of the State Geological Survey, and the larger portion of the State has been surveyed. Cooperative surveys have not been entered into by any of the Western States. The federal appropriations are little more than sufficient to survey one quadrangle (approximately 1,000 square miles) in each State and to extend the necessary triangulation and spirit-level control. The purposes which determine the selection of areas of topographic surveys are to a large extent economic, and are related to the development of mining districts, water resources and forest reserves. The first of these purposes includes also the surveys for general geology, which are usually extended over districts where economic interests are important. These topographic operations throughout the United States as planned for the present year are estimated to cover about sixty-five quadrangles on two different scales, or a total area of about 45,000 square miles.

The character of the topographic work is constantly improving, and the evolution of the topographer from the grade of a surveyor to that of a scientific observer is progressing. Whereas formerly the strongest man in any party was engaged in the more precise instrumental work, such as triangulation and leveling, and sketching topographic features was the work of subordinates, the reverse is now the case. The topographer in charge of the party is responsible for the expression of the map, which can only be satisfactory when controlled by experience and executed with artistic skill. Furthermore, the topographers are required to observe and note on the maps the classification of lands, as cleared or forested, and many of them take a scientific interest in the physiographic development of topographic forms. The tendency at the present time is to increase their responsibility and to make the place worthy of men ambitious to broaden knowledge of the conditions which fit the earth for man's habitation.

Geologic Branch.—In the northeastern district of the Appalachian province, comprising New England, eastern New York, and New Jersey, a number of competent geologists are engaged in the study of the difficult problems presented by the metamorphic sedimentary and igneous rocks. In the Adirondack area surveys of the southeastern portion of the mountains adjacent to Lake Champlain have been extended to cover nearly 1,000 square miles, lying between Lake Champlain and the

heart of the mountains. The greater part of the area is in the pre-Cambrian igneous rocks, and the problems relate to the sequence of eruptives and the character of metamorphism suffered by the anorthosites. The researches indicate an eruptive origin for the great magnetic ore bodies as parts of gabbro masses. A paper has been contributed to the 19th Annual on this subject (The Titaniferous Iron Ores of the Adirondacks, J. F. Kemp, 19th Annual Report). Preliminary surveys were begun last year in the region southwest of the Adirondacks in the Old Forge quadrangle, where the relations of igneous rocks to certain limestones are the more interesting questions.

The work begun by Pumpelly in the Green Mountains in Massachusetts, comprising the Housac and Greylock ranges, has been extended in several directions by those who were associated with him. In eastern New York, where Walcott had worked out the general outline of the problems, the complex stratigraphy and structure of the Paleozoic rocks have been unraveled practically from Manhattan Island to the vicinity of Rutland, and the relations of Cambrian and Silurian strata to Archean and Algonkian nuclei in northeastern Massachusetts and southern Vermont have been further investigated. Nearly all of Massachusetts as far east as the edge of the Boston basin has been surveyed according to the classification of the rocks published by Professor Emerson in the Holyoke folio and in the Monograph on old Hampshire county, and this work is progressing from the Massachusetts line southward in Connecticut. The difficulties of determining the origin and relationships of the unfossiliferous gneisses and schists which make up this area are so great that progress will probably be slow and differences of opinion may arise. It is accordingly advantageous that representatives of the several great universities are engaged upon the work.

In the eastern part of New England special studies have been made of the post-Cretaceous formations of the Elizabeth Islands and of Nantucket and Cape Cod; and an elaborate investigation of the Narragansett coal field has been completed, the results being published in Monograph XXXIII., entitled 'Geology of the Narragansett Basin,' by N. S. Shaler, J. B. Woodworth and August F. Foerste. In northern New Jersey surveys have been made of the Franklin Furnace quadrangle, including the celebrated zinc mines. A topographic map on a specially large scale was made, and through the courtesy of the companies the mine maps are available. These results will all be published in the Franklin Furnace folio of the Geologic Atlas.

For several years the geology of Manhattan Island and vicinity has been studied in its various aspects. The topographic surveys have been brought up to date, and it is proposed to issue a New York special folio, comprising about fourteen maps, to exhibit the surficial geology, under geology, structure and economic resources of the Patterson, Harlem, Staten Island and Brooklyn quadrangles. The field work for this folio is completed.

In the vicinity of Philadelphia the crystalline schists and gneisses present relations not unlike those of similar rocks in New England. Their distribution and relations have been worked up, and the results are to be elaborated in the Philadelphia folio of the Geologic Atlas, comprising the Germantown, Norristown, Chester and Philadelphia sheets. Through cooperation with the Maryland Geological Survey and through the work which has been in progress in Virginia, North Carolina and Georgia for ten years or more, a fairly complete reconnaissance of the crystalline schists has been accomplished throughout the Appalachian province, and their detailed relations have been unraveled in the

vicinity of Baltimore, Washington, and to some extent in the Smoky Mountains of North Carolina. The coordination of the observations in the pre-Cambrian rocks is entrusted to Professor Van Hise. The results will be published in part in cooperation with the Maryland Survey, in future folios of the Geologic Atlas, in the Washington folio, for which the manuscript is in hand, and in reports and folios relating to the Cranberry and Cherokee districts of North Carolina. This last-named work is performed partly in cooperation with the State Geological Survey of North Carolina.

In the Atlantic Coastal Plain the latest contributions to geology have resulted from the investigations supported by the State Surveys of New Jersey and Maryland. The study of the surficial deposits broadened the basis of stratigraphic discrimination, and the combination of minute observations in stratigraphy with elaborate studies of paleontology has led to recognition of important details in the Eocene and Miocene sections. Our views of unconformity and of the nature of oscillation of the Coastal Plain will probably be widened by the publication of these results. That, however, is not yet an immediate prospect, except in so far as they have appeared in the State reports of New Jersey and Maryland.

Surveys of the unaltered Paleozoic strata in the folded zone of the Appalachian province are not now being extended. The number of quadrangles surveyed and folios issued or about to be issued is large. With the exception of one folio, the Maynardville, shortly to appear, the valley and a part of the plateau region of eastern Tennessee are mapped in published folios, and the area of continuous surveys extends into Georgia and Alabama on the south and into Virginia on the north. Representative folios for the valley of northern Virginia cover over 6,000 square miles and fully exhibit the peculiarities of structure. Folios relating to Paleozoic stratigraphy and Appalachian structure issued during and since 1896 are Nos. 27, 28, 32, 33 and 35, or the Morristown, Tenn.; Piedmont, Va., Md. and W. Va.; Franklin, Va. and W. Va.; Briceville, Tenn., and Gadsden, Ala., respectively.

The accuracy of the work performed by geologists who preceded the United States Survey in the Appalachian coal fields, and the importance of the economic interests involved, led to the use of the most careful stratigraphic and structural methods in that field. Unwilling to trust to correlation of lithologically similar strata which have not been mapped continuously, the geologists have measured and named local sections on the assumption that they may not be able to correlate the individual beds in each. The position of any stratum is determined throughout a network of intersecting sections which are checked against the bench marks established by precise level lines in course of the topographic survey. Lithologic variations are carefully noted from area to area, and each distinctive lithologic unit is identified so far as it is actually traceable, but correlation is not continued beyond that point. The stratigraphers have been greatly aided by the appreciative cooperation of the paleobotanist, and the result will be to establish our knowledge of the stratigraphy of the Coal Measure formations upon a sound basis of fact. The tendency of the observations is to replace the conception of uniform and widely extended strata by the recognition of numerous irregular and overlapping lenses, and to demonstrate that the later Carboniferous formations exhibit the character of coastal plain deposits rather than that of marine strata. The folios more recently published with reference to the Appalachian coal field are Nos. 34, 40, 44, 46 and 47, or the Buckhannon, W. Va.; Wartburg, Tenn.; Tazewell, Va. and W. Va.; Richmond, Ky.,

and London, Ky., respectively. The last two, the Richmond and London, include the western margin of the field. The eastern margin is described in several of the folios published, and others are in course of preparation.

Studies in Pleistocene geology have been pursued by Professor Chamberlin and his assistants during more than a decade. Through a conservatism which justifies confidence, even though the impatient may at times have thought it excessive, the publication of results has been postponed until the criteria for discriminating the several episodes of glacial occupation and the various genetic types of glacial formations have been fully elaborated. The final preparation of manuscript was, however, begun nearly two years ago, and the first of a series of monographs upon the Pleistocene history (Monograph XXXVIII., The Illinois Glacial Lobe, by Frank Leverett) is issued. In this connection also may be mentioned Monograph XXXIV., The Glacial Gravels of Maine and their associated Deposits, by Geo. H. Stone.

The extraordinarily difficult investigation of the relations of iron-ore deposits in the Lake Superior region, which was begun by Irving and has been continued under Van Hise, is approaching a successful completion. All of the great iron-producing districts except two have been carefully surveyed, and the field work on these, the Vermilion and Mesabe districts of northern Minnesota, is far advanced. The series of monographs which set forth the observations and conclusions are a monument to the scientific spirit and executive ability of their authors. It is probably not too much to claim for them a foremost place in the rank of great geologic works. Very rarely has a problem of equal magnitude and difficulty been so elaborately studied and adequately solved. The principles of investigation developed in the course of this work are a contribution to geologic methods and will facilitate further researches of a similar character. To name only the latest of the resulting publications, reference may be made to Monographs XXVIII. and XXXVI., the former entitled 'The Marquette Iron-bearing District of Michigan,' by C. R. Van Hise and W. S. Bayley, and the latter, 'The Crystal Falls Iron-bearing District of Michigan,' by J. M. Clements and H. L. Smythe, published also in condensed form in the 19th Annual.

Studies of the stratigraphy of the Great Plains, more especially of the content of artesian waters, form an important item in the list of activities of the Survey. In the Pueblo folio the standard was set for precise discrimination of the formations and adequate illustration of their distribution and structure. The Geologic Branch, cooperating with the Hydrographic Branch, has extended more general investigations over parts of Nebraska and South Dakota. At present the surveys are being executed for the eastern and south margin of the Black Hills and the adjacent plains. The latest contribution to the subject is a preliminary report on the geology and water resources of Nebraska by N. H. Darton in the 19th Annual Report. The 18th Annual also contained an article on 'New Developments in Well Boring and Irrigation in Southeastern South Dakota.' Observations of the temperatures of artesian waters have led to the discovery of interesting variations in underground temperatures which are being made the subject of careful investigation.

In the southern portion of the Great Plains province work is progressing in Indian Territory. The coal fields of Indian Territory are structurally related to a series of folded and faulted sandstones and limestones along their southern margin, as the Cumberland plateau is related to the formations of the Appalachian Valley. The coals

lie in basins of moderate depth, and the strata along their southern limb are sharply folded and overthrust. The progress of the work is such that the McAlester folio will probably appear during this fiscal year. Among the observations of scientific interest is the determination of strata of probable Silurian age in sandstones previously considered to be Carboniferous. In the 19th Annual there is an article entitled 'The Geology of the McAlester-Lehigh Coal Field,' by J. A. Taff.

The geology of Texas is associated with the name of Robert T. Hill. Under his direction a large map has been prepared of the State on the scale of 25 miles to the inch, including portions of Oklahoma, and an account of the physical geography has been written to accompany it. This will appear as a folio of the Topographic Atlas of the United States, coordinate with the folio on physiographic types. 'The Geology of Black and Grand Prairies, Texas,' a comprehensive discussion of the stratigraphy and structure of the Cretaceous and later formations, is completed and offered for publication, and an article on 'The Geology of Portions of the Edwards Plateau and Rio Grande Plain Adjacent to San Antonio, Texas,' by R. T. Hill and T. W. Vaughan, appeared in the 18th Annual.

The Rocky Mountains occupy the attention of several parties. There the problems of stratigraphy, structure, metamorphism and vulcanism make it scarcely possible for any one geologist to do justice to the phenomena of a single area, particularly in the present development of special branches of geologic research. In the San Juan Mountains of Colorado surveys have for several years been conducted with a degree of care and detail which must result in a mass of well established fact and afford the foundation for valuable generalizations. In age the formations range from supposed Archean to post-Tertiary; in character they include an immense variety of sedimentary and igneous types, and in structural relations bearing upon the problems of vulcanism and orogeny they are of the deepest interest. The exposures in the rugged but rarely inaccessible heights are very clear, and the work is being done on a scale which affords opportunity for the elaboration of detail. The district offers a definite though complex problem, and it is being worked out according to a systematic plan. The 18th Annual contains a preliminary report on the mining industries of the Telluride quadrangle by C. W. Purington, and the Telluride folio by Whitman Cross will shortly be issued.

Among the publications which serve to add materially to the available information concerning the geology of Colorado are the Elmoro, Walsenburg and Spanish Peaks folios, the manuscripts for which have recently been received by the Survey in accordance with a contract entered into a number of years ago. The area which they cover comprises a portion of the plains and the foothills of the Rockies and extends to the Spanish Peaks, where the phenomena of successive intrusions of various types of igneous rocks are exceedingly interesting. The relations of the eruptives have been elaborately worked out and appear to indicate a genetic sequence of petrographic types.

Although work in the precious metal districts is not confined to the Rocky Mountains, that which has been conducted under the general direction of Mr. Emmons may most connectedly be introduced here. This work is on a much larger scale than that of the geologic investigations as a rule, and is directed to the solution of problems of development of fissures and distribution and occurrence of ores. It involves usually the detailed study of an area specially surveyed on a large scale, and also the minute investigation of all accessible underground

workings. The examination of the Butte district was undertaken in 1896, and the Butte Special folio has been published. The Tintic district in Utah was surveyed in the following season, and the results appear in the 19th Annual Report under the title of 'The Geology and Mining Industry of the Tintic District, Utah,' by Geo. W. Tower, Jr., and Geo. Otis Smith.

The Deadwood district in the Black Hills of South Dakota next claimed attention, and areal and economic surveys are now in progress there. Apart from the economic interest, the region presents geologic features of comprehensive and significant character. The literature of the subject of laccoliths will receive an important addition when a report on the structural relations of the rocks in the Spearfish and Sturgis quadrangles is published. It is anticipated that this season will suffice to finish the necessary field work.

In Montana the work begun by Mr. Hague in the Yellowstone Park has, during a number of years, been extended northward nearly to the boundary of British Columbia, and surveys on the scale of 2 miles to the inch have replaced those on the formerly adopted scale of 4 miles to the inch. The Fort Benton and Little Belt Mountain quadrangles, covering together nearly 7,000 square miles, have been surveyed in connection with studies of the Neihart mining district. They will be published as folios of the Geologic Atlas. More detailed accounts of the geologic observations in Montana appear in the 19th Annual Report, Geology and Mineral Resources of the Judith Mountains of Montana, by W. H. Weed and L. V. Pirsson, and are contained in an elaborate article in the 20th Annual, 'The Geology and Mining Districts of the Little Belt Mountains,' by the same authors. This last is almost a monographic work, both in size and detail. Detailed areal surveys have been carried out in the Boulder and Helena. Special quadrangles, and topographic surveys in preparation for geologic work have been conducted in the Bitter Root Valley. The discovery by Mr. Walcott of pre-Cambrian fossils in the Belt terrane of Montana lends additional interest to the northwestern extension of the Rocky Mountains, of which these rocks form a large part.

Mr. Hague's monographic work upon the Yellowstone National Park has been energetically pushed, and the volumes are well advanced. The surveys of the Absaroka Range to the east of the Yellowstone Park are represented in the Absaroka folio, which will shortly be issued from the press. The remarkable phenomena presented by volcanic breccias laid in horizontal attitudes over a wide area, and by post-Miocene intrusives, have been discussed by Mr. Hague in his Presidential Address to the Geological Society of Washington, but are more fully illustrated and described in the Absaroka folio.

The Boise mining district, Idaho, attracted attention to a region which has since been the subject of surveys during several successive field seasons. Among the results is the determination of the probably post-Paleozoic age of a large granite area formerly considered to be Archean, and the elucidation of interesting episodes in the history of Snake River. A portion of these results are published in the 18th Annual as a paper entitled The Mining Districts of the Idaho Basin and the Boise Ridge, Idaho, by Waldemar Lindgren, and in the Boise folio, No. 45, and the 20th Annual contains an article entitled The Silver City, De Lamar and other Mining Districts in Idaho, by the same author. The work of the present field season is designed through reconnaissance to obtain a general knowledge of the areal geology of central and northern Idaho up to and including the Cœur d'Alene district of eastern Washington.

The desert region of Nevada south of the 40th Parallel Surveys is geologically almost unknown, and the blank in the geologic map of the United States is correspondingly extensive. Surveys are begun with the present field season to accomplish a reconnaissance of this area, extending south into southern California. If appropriations permit, it is hoped that reconnaissance surveys may, in the course of a few years, be extended over all of the little known districts of the United States, so that a complete geologic map may be published on the scale of what is known as the nine-sheet base, namely 40 miles to the inch.

The geological survey of the Sierra Nevada has been completed over an area comprising about 21,000 square miles between the 37th and 40th parallels of latitude. Twenty geologic folios have been or are to be published illustrative of the results. The work at the present time is proceeding in the Yosemite quadrangle and further south on the eastern slope of the Sierra Nevada in the Silver Peak quadrangle, which includes the Silver Peak mining district. Following the general study of the mountain range and its geologic structure, special work has been done upon some of the principal mining districts—for instance, that of Nevada City, and more recently upon the Mother Lode. For the last-named work a large-scale topographic map was prepared with great care, and Mr. Becker entered upon the studies of physics of ore deposition along the lode. In July, 1898, he was, however, diverted therefrom by an assignment to ascertain the mineral resources of the Philippines. The performance of this duty required the acceptance of a military commission, and he was attached to the Bureau of Information at Manila. Geologic investigations being precluded by the activity of the insurgents, Mr. Becker accepted his military duties with sang froid, and with the troops under fire rendered service which has been the subject of highly complimentary reports from his superior officers in the field. The information which he was able to obtain in the old Spanish bureau of mines in Manila and presumably from other reliable sources is contained in Part VI., of the 19th Annual Report.

In the Cascade Range of Washington studies conducted for the past two years with reference to the geology of the Mount Stuart quadrangle reveal a series of phenomena closely resembling those of the Sierra Nevada. The volcanic flows of which the range is composed throughout Oregon and into southern Washington give place about latitude 46° 30′ to schists and granites of pre-Tertiary age, which are unconformably overlain by sandstones of the Eocene and Miocene periods. The structure of the range cannot be said to be understood at the present time, but work is energetically proceeding with the purpose of developing the facts in such detail and so accurately as to secure conclusive information. A reconnaissance of the northern portion of the range carried out during the past summer has resulted in an article in the 20th Annual—Geology of the Cascade Mountains of Northern Washington, by I. C. Russell.

In the Coast Ranges of California and Oregon, a geologist who has acquired ideas of mountain growth from the Paleozoic rocks of the Appalachian province must completely revise his conception of that process. Where the early Cretaceous or late Jurassic rocks appear as a schistose basement complex, and the Cretaceous and Tertiary formations are separated by as many unconformities as there are distinct episodes of history, the activity of the earth's crust seems an imminent phenomenon. The contributions to the stratigraphy and structure of these youngest ranges proceed from studies in Oregon (Coos Bay Coal Field, Oregon, J. S. Diller, 19th An-

nual Report, and the Roseburg folio, Oregon, J. S. Diller), and in California from investigations by the professors of Berkeley and Stanford in the vicinity of San Francisco, and of the San Luis Obispo district, comprising the vicinity of the town of that name. At present surveys are being prosecuted on the Klamath Mountains, where strata of early Paleozoic age are identified by fossils; on a series of quadrangles which include San Francisco and a section across the Coast Range eastward to the San Joaquin Valley; and about San Luis Obispo.

In the work of the Geological Survey outside of the Appalachian province, physiography has received scant attention. The development of the mountain ranges from the Great Plains to the Pacific is recorded in physiographic forms which are as significant as facts of stratigraphy and igneous eruptions, and which continue the record made in the rocks. The physiographic province bounded by these eastern and western limits and extending from the Isthmus far into British Columbia presents problems which are as yet unconsidered. In order that they may be studied in all their breadth and comprehensiveness within the United States, Mr. Gilbert has been assigned to the investigation. The results may confidently be expected to afford an interesting group of criteria for the elucidation of mountain history, and to advance the solution of continental problems.

Petrography and paleontology, two great aids to general geologic research, have each a special purpose of investigation intimately related to other sciences. The results achieved by the specialists who are members of the Geological Survey are proportionate to the opportunities, which are broad and numerous; but in this partial and general account of the work of the Survey it is not practicable to go into details concerning them. The 19th and 20th Annuals, however, contain important contributions of general interest, namely: 'The Cretaceous Formations of the Black Hills as indicated by Fossil Plants,' by L. F. Ward; 'Status of the Mesozoic Floras of the United States,' L. F. Ward; and 'The Flora of the Pottsville Series, David White. In the 20th Annual Professor Pirsson's contribution to the petrography of the Little Belt Mountains, Montana, is an important paper.

The Division of Mineral Resources prepares a statement of the quantity and value of the products from the mines of the United States, and also special reports on new features of mining technology in relation to mineral industries. Many inquiries which come to the Interior Department in regard to questions on mineral technology of every character find their way to this division for reply. There is opportunity for development of the scope of this work in response to the agitation among mining interests for representation in the executive branch of the National government. An amendment to the Sundry Civil Bill was introduced in the Senate at the last session of Congress authorizing the Director to establish a Division of Mining in the United States Geological Survey. While the establishment of a Division of Mining was not completed by the House of Representatives, the appropriation for the work was changed from $20,000 to $30,000 and the Survey is enabled to inaugurate some of the features contemplated. For example, through cooperation with the geologic branch, there will be made a study of the conditions of occurrence of asphaltum, a mineral of constantly increasing usefulness, to secure a complete account of the various deposits in the United States. Corundum, a demand for which has become imperative in this country, will be examined in the same way. A comparison of tests as to the physical strength and chemical composition of building stones of the country, published within the last month, illustrates

the possible scope of these operations. Similar comparisons of information concerning the composition of the various fuels of the United States are urgently required, and it is proposed to undertake them.

Hydrographic Branch.—The Hydrographic Branch of the Geological Survey devotes its energies mainly to the measurement of the volume of streams, chiefly in mountainous regions. About three-fourths of the stations maintained are west of the 97th meridian, a greater portion of the remainder being in the Appalachian Mountains. In addition to the work of stream measurements systematic information regarding the methods and results of the utilization of the water supply of the country is being obtained from all sources where it can be found in the hands of individuals and corporations and published in a series of 'Water Supply and Irrigation Papers.' Geological examinations of the artesian districts of the Dakotas and of Texas are also in progress, and various problems of a scientific nature are under investigation. In connection with stream measurements the attempt is being made to measure carefully the slope of streams and to describe their regimen, in order to obtain additional information regarding the proper coefficients of friction to be used in hydrographic formulæ. The movements of underground waters are being observed by means of wells and other available sources of information, this work being chiefly done in the Great Plains region and the valleys of California. Where possible, existing information regarding artesian and surface wells is being obtained and tabulated.

The branch being charged by law with the examination and segregation of reservoir sites, those which come within the studies pursued are surveyed and segregated from private entry under the homestead and desert land laws, in order to prevent the vestment and growth of private interests which might in future be an obstacle to the best utilization of such sites.

Forestry Investigations.—The agitation for the preservation of the remaining forests of the United States resulted in the establishment of two distinct classes of work, both having reference to the forests. The one might be comprehensively described as a forest survey, its purpose being to obtain maps of the forested areas throughout the country and to set forth the present condition and future prospects of the forest reserves. The other relates to the administration of the established forest reserves, involving the appointment and supervision of numbers of rangers whose duty it is to prevent fires and depredations and to see that the laws governing the reserves are enforced.

The forest survey is in charge of the Director of the Geological Survey, and is under the immediate management of Mr. Gannett, except in so far as the topographic work, which supplies the base maps, is executed by the divisions of the Topographic Branch. It is carried out in cooperation with similar investigations conducted by the Forestry Division of the Agricultural Department under Mr. Gifford Pinchot. With the energy and capacity for broad generalizations which characterize his work, Mr. Gannett has caused the principal forest areas of the country to be investigated, and some part of the results is already published. They constitute Volume V. of the 19th Annual, and the fifth volume of the 20th Annual will also be composed entirely of papers relating to forests.

Publications Branch.—Standards of scientific and literary character were established for the textual publications of the Geological Survey early in its history. Their present style is in large measure due to the efficient work of the editor and his assistants. The magnitude of the labors of this branch can best be suggested by a state-

ment of the number of typewritten and printed pages handled during the past year. The manuscript pages, usually typewritten, amounted to 16,263, and proof sheets read and corrected during the year to 10,840; the latter, as a rule, were read twice. The editorial work increases with the growth and diversity of the Survey's work. Thus for five years, 1889 to 1894 inclusive, the number of manuscript pages edited was 46,891 and of proof pages read 22,795, whereas during the equal period from 1894 to 1899 inclusive, the corresponding numbers were 65,763 and 35,769.

The work of the Engraving Division also grows from year to year, as the output of original maps from the topographic and geologic branches is enlarged. The Chief Engraver has ingeniously simplified the technical processes, and he has organized his force on the best models of private business enterprise. The precise cost of each item of engraving, correcting, or printing is ascertainable, and the efficiency of each worker is demonstrated. To a certain extent this reacts upon the scientific branches of the Survey, since the character of original manuscripts may be such as to facilitate or to impede the work of reproduction. But in spite of efficient organization the division is not equal to the tasks imposed upon it. The publication of topographic maps (of which the number is being increased by cooperation) and the issues of geologic folios will be delayed if the appropriation for this work is not materially enlarged.

Following the precedents set under King and Powell, it has been the policy of the present Director of the Survey to secure the strongest men available for each branch of the work, and to encourage the development of individual members. Among the gratifying results of this policy was the cordial recognition of the service rendered by members of the Geological Survey, Messrs. Hayes and Davis, attached to the Nicaragua Canal Commission under Admiral Walker. In the last four years the geologic personnel has been increased by the addition of a number of strong men, recently graduated from the leading centers of geologic instruction. Several of them entered through Civil Service examination, and others, whose university work succeeded practical field experience on the Survey, came back to it after their years of study. It has been said in the course of discussions concerning a National University that the Geological Survey at present constitutes the geologic branch of such a university, since it receives post-graduate students from the highest universities in the country and gives them opportunity to pursue independent researches in geology.*

BAILEY WILLIS.

SCIENTIFIC BOOKS.

POINCARÉ'S COURS DE PHYSIQUE MATHÉMATIQUE.

Théorie du potentiel Newtonien. Par H. POINCARÉ. Rédigées par ÉDOUARD LEROY et GEORGES VINCENT. Paris, Georges Carré et C. Naud. 1899. 8vo. Pp. 366.

Cinématique et mécanismes, potentiel et mécanique des fluides. Par H. POINCARÉ. Rédigé par A. GUILLET. Paris, Georges Carré et C. Naud. 1898. 8vo. Pp. 385.

The fertility in mathematical resources of the eminent author of these volumes and the wide range of physical questions which he has illuminated by means of those resources excite at once our surprise and our admiration. He has proved, in fact, that it is still possible, as it was

* The preceding article is not intended to present a complete catalogue of the activities of the Geological Survey or of its publications. The administration, distribution of work and funds, and the assignment of the personnel, are given in detail in the Director's Annual Report, issued in December of each year, and may be had on application to the Director of the Geological Survey. Complete lists of the publications are kept as nearly up to date as possible and may be had on request.

in the days of Laplace and Gauss, for one mind to possess a working knowledge of the entire group of the mathematico-physical sciences.

An idea of the comprehensive scope of this *Cours* may be gained by the following list of titles to the preceding ten numbers of the series: 1°, Théorie mathématique de la lumière, I., 1 Vol.; 2°, Électricité et Optique, 2 Vol.; 3°, Thermodynamique, 1 Vol.; 4°, Leçons sur la Théorie de l'Élasticité, 1 Vol.; 5°, Théorie mathématique de la lumière, II., 1 Vol.; 6°. Théorie des Tourbillons, 1 Vol.; 7°, Les oscillations électriques, 1 Vol.; 8°, Capilarité, 1 Vol.; 9°, Théorie analytique de la propagation de la chaleur, 1 Vol.; 10°, Calcul des probabilités, 1 Vol. These, together with the two works announced above, which are Nos. 11° and 12° of the series, make a total of thirteen octavo volumes devoted to at least ten fairly distinct subjects of mathematical physics. All of these volumes have appeared within a period of about ten years, during which the indefatigable author has found time also for many researches in pure mathematics and for important contributions to dynamical astronomy.*

The reader who is not already acquainted with this important series of works will naturally enquire what are its characteristic features and what are the advantages to be gained by a study of this rather formidable aggregate of three to four thousand pages of intensely mathematical literature.

In the first place, it should be said that the works are in no sense treatises. They assume, in general, a considerable knowledge of the subject on the part of the student, and do not attempt, as a rule, to give that degree of detail which is essential in an elementary presentation. Secondly, it must be said that these works are much more mathematical than physical. Indeed, it will doubtless appear to some that the title of the series ought to be Cours de mathématique physique; for the ease with which the author substitutes mathematical abstractions for physical realities is often painful to one who is at all conscious of the obstinate properties of matter. In many cases, also, the formulas dealt with are entirely divested of the factors which are indispensable to their use by the physicist; so that while the mathematical argument may proceed unimpeachably the results attained are often quite unsuited for the physical laboratory or the computer's mill. But let no mathematician who has the slightest liking for physical applications and no physicist who has a fondness for mathematical methods of research be deterred by such trifling matters of detail from an attentive study of these volumes. For the mathematician will find in them a wealth of beautiful analysis satisfying all the canons of modern precision and at the same time not obtrusively technical and practical; while the physicist, on the other hand, will be delighted and instructed by the luminous expositions of obscure questions, by the fresh and rigorous proofs of old theorems, by the more refined processes of modern analytical procedure, and by the sharper limitations of the fields explored. In short, it is one of the prime merits of these works that they afford a common ground on which the pure and applied mathematicians may meet to their mutual advantage. Of course, there must be some concessions. The pure mathematician must admit, while reading the *Cours*, at any rate, that the phenomena of nature present intricate though special and perhaps grossly utilitarian illustrations of his general theorems; and the physicist must own, with due contrition, that it is not uninteresting and profitless, occasionally, to free one's self from the restrictions of matter, or even to investigate the imaginary properties of hypothetical mediums.

The volume devoted to the Thèorie du potentiel Newtonien is chiefly concerned with the properties and application of the function dependent on the law of the inverse square of the distance, but considerable attention is given also to the logarithmic potential, which has come to play an important rôle in some physical problems. The book is divided into nine chapters. The first deals with the potential at a point external to the attracting mass, with the equation of Laplace and with the harmonic developments of the potential function. The second is concerned with the potential at a point internal to the attracting mass, and with the equation of Poisson. The third is devoted to the potential

* Especially his 'Nouvelles théories de mécanique céleste.'

due to surface and line distributions of mass. The fourth and fifth are occupied with the function of Green and the problem of Dirichlet. The sixth gives an exposition of the potential theory as applied to double strata (double couches); that is, two infinitely near surface or stratum distributions of equal but opposite densities. The seventh and eighth continue the consideration of the problem of Dirichlet, the former by means of the process of Green's equivalent stratum (here called La methode du balayage), and the latter by the method of Neumann. The ninth chapter is devoted to an extension of the method of Neumann to the case of simply connected regions, and to certain functions (called Fonctions fondamentales) which conform to the conditions of the potential function due to a simple surface distribution of mass.

The treatment of the subject, except for the few final pages in which the 'fonctions fondamentales' are discussed, is very precise from the purely mathematical point of view. "J'ai cherché," the author says, p. 348, "à donner partout à mes raisonnements un charactère de parfait rigueur." For this reason the work will doubtless prove most interesting to the mathematician and most instructive to the physicist. But the latter can hardly conceal the regret that his demands for precision are not equally met. Thus, to cite some illustrations, the Newtonian potential is defined by the equation

$$V=\Sigma\frac{m}{n},$$

where m is any element mass and r its distance from the attracted mass; and we are told that the components of attraction in the coordinate directions are

$$X=\frac{\partial V}{\partial x},\ Y=\frac{\partial V}{\partial y},\ Z=\frac{\partial V}{\partial z};$$

but not a word is said about the gravitation constant nor of the difficulties a reader who may know the dimensions of force may have in interpreting $\partial V/\partial x$, etc. Again, how do 'potentiel newtonien d'une surface sphérique homogène' and 'potentiel logarithmique d'une circonférence' sound to one whose imagination is always shocked by the suggestion of surface and line distributions of real matter? Again, on p. 215, ξ, η, ζ figure as components of a velocity, but on p. 217 the author says: "Supposons maintenant que le vecteur ξ, η, ζ soit, en chaque point, normal à la surface, c'est-a-dire que l'on ait:

$$\xi=a,\ \eta=\beta,\ \zeta=\gamma,$$

a, β, γ désignant les cosinus directeurs de la normale au point x, y, z." The reader will find out, of course, sooner or later, how to remove these inconsistencies, but it would have been very easy to avoid them entirely and to have thus fulfilled the requirements of the physicist as well as those of the mathematician.

English students of the theory of the potential will be glad to find good French authority for the term Laplacian as applied to the sum of the three second derivatives of the potential with respect to the coordinate directions. Thus, for example, the author writes, p. 118, "Le laplacien ΔV, more commonly written $\Delta^2 V$ or $\nabla^2 V$ by English writers, 'fait un saut brusque. . ."

The most important technical features of the book are to be found in the investigations of the potential of single and double surface distributions, in the considerable space devoted to the logarithmic potential, and in the thorough though tedious treatment of the problems of Green and Dirichlet.

The volume on kinematics, potential and hydromechanics presents an unusual though not incongruous combination of subjects. A good knowledge of kinematics and a considerable acquaintance with the potential theory are, in fact, necessary preliminaries to the study of the mechanics of fluids.

Over half of the book, 200 pp., is devoted to kinematics and mechanism. Beginning with the elements of the subject, Chapter I treats of the rectilinear and curvilinear motions of a point, Chapter II of the coplanar motion of an invariable figure, Chapter III of the motions of a rigid body, Chapter IV of helicoidal motions (theory of screws), Chapter V of the relative motion of a point, and Chapter VI of the motions of various forms of mechanisms, including belts, gearing, links, etc. In the development of the purely kinematical principles the author supplies both geometrical and analytical proofs. Many of the former and some of the latter appear to follow new lines in this

well gleaned field. This work does not seem to be, as a whole, very satisfactory, however, in view of the heavy drafts which kinetics and some branches of applied mechanics now make on kinematics. A more condensed and a more analytical treatment would have been clearer, we think, and would have left room for some important generalities omitted, especially such as are essential in hydrokinetics, in elasticity, and in the kinetics of non-rigid bodies. There is in this part also an occasional departure from the modern demands for mechanical precision, as on pp. 10, 11, where, by the unnecessary suppression of a length symbol, the ancient fallacies of the equality of linear and angular velocities and of linear and angular accelerations are revived. Again, to cite another illustration of a lack of clearness, in Chapter V, which is entitled 'Mouvement relatif d'un point,' and which considers the motion of a point referred to two sets of rectangular axes, one of which moves in any manner with respect to the other, the author says, p. 121: "On peut avoir à considérer trois mouvements: 1° le mouvement du point M par rapport aux axes fixes ou mouvement absolu; 2° le mouvement des axes mobiles ou mouvement d'entraînement; 3° le mouvement de M tel qu'il apparaîtrait à un observateur invariablement lié aux axes mobiles ou mouvement relatif." This shows also, among other things, that it is still easy to speak of the absolute even in mechanics.

The second part of the book presents, in the first two chapters, a rather elementary introduction to the theory of the force function, potential function and the flux of force, and to Green's theorem and Dirichlet's problem. There is added, also, in the third chapter, an elementary investigation of the attraction of ellipsoidal shells and of a homogeneous ellipsoid.

The most interesting and important chapters of the book are the last two, which are devoted to hydromechanics. The treatment is confined to the ideal case of perfect fluids and is, on the whole, elementary. About 60 pages are given to the theory and applications of the principles of hydrostatics. Most prominent and important among the applications is the somewhat extended discussion of the conditions of equilibrium of floating bodies. Among many instructive results it is shown that a right homogeneous cylinder may float in stable equilibrium in four different positions, in one of which its axis is vertical, in one horizontal, while in the other two the axis is oblique to the vertical.

The final chapter, of 61 pages, is devoted entirely to hydrokinetics. Proceeding from the Lagrangian to the Eulerian equations of motion, the author develops the elements of the subject with unusual clearness and mathematical elegance. After the introduction and definition of the velocity potential the theorem of Lagrange —once a potential always one—is demonstrated by an apparently new proof, which seems peculiarly well adapted to show the meaning and limitations of the theorem. The beautiful and very important theorem of Bernoulli is also demonstrated in a new and rigorous fashion. The part of the chapter dealing with irrotational motion closes with an exposition of the motion of liquids under gravity in the case wherein the products of the component velocities and their space derivatives can be neglected.

The rest of the chapter is concerned chiefly with vortex motion (vortices, tourbillons). Here also there is much fine mathematical work, though the notation is in some respects repulsive and though the printer would appear in some places to have sown his d's and ∂'s broadcast. On pp. 348–353 there is some especially interesting work preliminary to the proof of Helmholtz's theorem that the molecules once observed to be on a vortex line remain on it. This work consists in the proof of three special theorems drawn from the general equations of rotational motion for the particular case of steady motion. Let at any point x, y, z of the fluid

$$E = -T - V - \int^{p} \frac{dp}{\rho}$$

where T and V are the kinetic and potential energies respectively per unit mass, p is the pressure, and ρ is the density assumed to be dependent on p only. Then: 1st, for steady irrotational motion, for which the component spins and accelerations of the molecules vanish, it appears at once that E is constant throughout the mass, which is Bernoulli's theorem generalized; 2d, when the motion is steady but ro-

tational, E is constant along the same stream line (filet) defined by the equations

$$\frac{dx}{u} = \frac{dy}{v} = \frac{dz}{w},$$

where u, v, w, are the component velocities of the particle; 3d, when the motion is steady but rotational, E is also constant along the same vortex line, defined by the equations

$$\frac{dx}{p} = \frac{dy}{q} = \frac{dz}{r},$$

where p, q, r are the component spins.

Then follow a proof of the theorem of Helmholtz, above cited, and of the theorem that in the case of a liquid filling a recipient the velocity components u, v, w are determinate if the spins p, q, r are known at any instant. Several very instructive special cases of vortex motion are also considered; and the chapter closes with an exposition of the problem of the motion of a solid in a liquid, application being made especially to the case of pulsating spheres studied by Bjerknes. R. S. W.

The Elements of Vital Statistics. By ARTHUR NEWSHOLME, M. D. Third Edition. London, T. Swan Sonnenschein & Co., and New York, The Macmillan Company. 1899. Pp. xii + 353.

That a third edition of this book has been demanded within ten years of its first appearance is gratifying evidence of a growing public interest in Vital Statistics and an appreciation of sound and careful work. Vital Statistics, interpreting that phrase in a somewhat larger sense than is done by this writer, is probably the best avenue along which to approach the general field of statistics. It is the oldest, most developed and most systematized branch of the subject, and, if properly handled, can be made of great interest even to beginners. For these reasons I have long felt that the book of Dr. Newsholme was, perhaps, as good an introduction to statistics as anything in the English language. There is no American book to be compared with it, for the articles by Dr. J. S. Billings and Dr. Roger S. Tracy are buried in pages of other matter, one in a medical journal and the other in an encyclopædia, and neither vies in simplicity or fullness of treatment with the present work. This third edition is almost a new book, embracing fewer tables, more graphic illustrations, more references to results obtained in foreign countries and many new subjects. From the American standpoint it may be criticised as confined somewhat too closely to topics which especially interest English sanitary and medical statisticians. But as England is *facile princeps* in this field and the United States as a whole is inferior, not merely to those countries of Europe with which we naturally compare ourselves, but even to Russia, Greece, Spain and the colonies of Australia, the objection is not a serious one. During years of critical use of Dr. Newsholme's book I have never found in it a serious error of statement and the argumentative parts are sound, temperate and convincing. It is a typically English book, caring little for theory or refinements of analysis unless they have a clear bearing on the results, but strong in all such practical discussions as statistical evidence for the utility of vaccination, causes of infant mortality, or the fallacies to which statistical arguments are exposed. WALTER F. WILLCOX.

CENSUS OFFICE.

BOOKS RECEIVED.

Anatomie des Frosches. A. ECKERT and R. WIEDERSHEIM. Revision by DR. ERNEST GAUPP. 2d Edition. Braunschweig, Friedrich Vieweg und Sohn. 1899. 2d Part. Pp. 237-548 + xii.

Praxis und Theorie der Zellen-und Befruchtungslehre. VALENTIN HÄCKER. Jena, Gustav Fischer. 1899. Pp. viii + 260. Mark 7.

Fixirung, Färbung und Bau des Protoplasmas. ALFRED FISCHER. Jena, Gustav Fischer. 1899. Pp. x + 362. Mark 11.

Folk-lore in Borneo. WILLIAM HENRY FURNESS. Wallingford, Pa., Privately Printed. 1899. Pp. 30.

Sewage Analysis. J. ALFRED WANKLYN and WILLIAM JOHN COOPER. London, Kegan, Paul, Trench, Treübner & Co., Ltd.; Philadelphia, J. B. Lippincott Company. 1899. Pp. xvi + 220. $2.00.

New Plane and Solid Geometry. WOOSTER WOODRUFF BEMAN and DAVID EUGENE SMITH. Boston, Ginn & Company. 1899. Pp. ix + 382.

SOCIETIES AND ACADEMIES.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—PRELIMINARY PROGRAMS.

SECTION A, MATHEMATICS AND ASTRONOMY.

'REPORT on Progress in Non-Eulidean Geometry,' George Bruce Halsted, University of Texas, Austin, Texas.

'Report on recent progress in the theory of linear groups,' L. E. Dickson, University of California, Berkeley, Cal.

'Recent advances in the application of mathematics to physical problems,' A. S. Hathaway, Rose Polytechnic Institute, Terre Haute, Ind.

'Recent progress in theoretical meteorology,' Cleveland Abbe, Weather Bureau, Washington, D. C.

'Recent progress in positional astronomy,' J. R. Eastman, Andover, N. H.

'Practical astronomy during the first half of the present century,' T. H. Safford, Williamstown, Mass.

'Internal forces that generate stellar atmospheres,' J. Woodbridge Davis, New York City.

'The determination of the nature of electricity and magnetism, including a determination of the density of the ether,' R. A. Fessenden, Western University, Allegheny, Pa.

'Ancient eclipses and chronology,' R. W. McFarland, Oxford, Ohio.

'Some points in the design of a spectroscope,' H. C. Lord, Ohio State University, Columbus.

'The relation between point and vector analysis,' J. V. Collins, Stevens Point, Wis.

'William Hamilton, Hermann Grassmann und deren Widersacher,' Ferdinand Kraft, Zurich.

'The theory of mathematical inference,' G. J. Stokes, Queen's College, Cork, Ireland.

'The magnetic work of the Coast and Geodetic Survey,' L. A. Bauer, Coast and Geodetic Survey, Washington, D. C.

SECTION G, BOTANY.

Vice-Presidential Address, Charles R. Barnes.

'Division of the megaspore of Erythronium,' John H. Schaffner.

'The embryo-sac of Leucocrinum montanum,' Francis Ramaley.

'The occurrence of Lignum and Calcium Oxalate during differentiation of the buds of Prunus americana,' H. C. Bolley.

'The flora of Franklin County, Ohio,' A. D. Selby.

'Studies of the vegetation of the high plains of western Nebraska,' C. E. Bessey.

'The geotropism of the Hypocotyl of Cucurbita,' Edwin Bingham Copeland.

'Notos on the long-leaved (Longifoliæ) Willows,' W. W. Rowlee.

Sullivant Day—Papers on bryological subjects, especially relating to the work of Sullivant and the progress in bryology since his time. Exhibition of his type specimens, collections, publications, portraits and other mementos.

'On the occurrence of the black rot of cabbage in Europe,' H. A. Harding.

'Duration of bacterial existence under trial environments,' H. C. Bolley.

'Cultures of Uredineæ in 1899,' J. C. Arthur.

'Field experiments with 'Nitragin' and other germ fertilizers,' Byron D. Halsted.

'Some notes on subterranean organs,' A. S. Hitchcock.

'The Tamarack Swamps in Ohio,' A. D. Selby.

'Some monstrosities in spikelets of Eragrostis and Setaria with their meaning, W. J. Beal.'

'Botanical Teaching in the Secondary Schools,' W. C. Stevens, Ida Clendenin.

'Suggestions looking toward a more rational basis for the classification of the Pleurocarpous Mosses,' A. J. Grout.

'Basis for generic and specific characters in the Uredineæ,' J. C. Arthur.

'Two diseases of Juniperus caused by Trametes pini and Polyporus carneus,' Herman Von Schrenk.

'The effect of hydrocyanic acid gas upon the germination of seeds,' C. O. Townsend.

'Physiological effect of hydrocyanic acid gas upon young fruit trees,' W. G. Johnson.

'Are the trees advancing or retreating upon the Nebraska plains?' C. E. Bessey.

'Etiolative Reactions,' Wm. B. Stuart.

'The Mycorhiza of Tipularia,' Julia B. Clifford.

'Cytological studies in the Hepaticæ,' Bradley M. Davis.

'A thousand miles for a fern,' C. E. Bessey.

'The distribution of lichens in the Mississippi Valley,' B. E. Fink.

DISCUSSION AND CORRESPONDENCE.

THE FOEHN WINDS OF SWITZERLAND.

Mr. Ward's review, in Science of July 21st, of Billwiller's classification of the *Foehn* winds

is very interesting and instructive. Attention should, however, be called to the fact that the correct name is not *Foehm* (*Föhm*), as it there appears, but *Foehn* (*Föhn*), or *Foen* (*Fön*), the form with *h* being preferred. *Foehn* is derived probably from the Italian *favonio*, which in turn is from the Latin *favonius*, the name of a gentle *west* wind. Hence the Italian west wind becomes a Swiss south wind. In Latin and Italian the word is masculine; in German it is usually treated as masculine, but Grimm quotes an interesting passage from an old gloss in which it is used as feminine. The character of this wind is as uncertain as the gender, the etymological meaning being 'the favoring one,' but the following extracts translated from Schiller's William Tell show how the Swiss on Lake Lucerne dread the *Foehn*, 'the mighty spirit,' as it has been called. Ruodi, the fisherman, exclaims: "The *Foehn* has broken loose; you see how wild the lake is. I cannot steer against storm and waves." Baumgarten answers: "God help you! How I pity you!" In another place Tell says: "When the *Foehn* sweeps down from its ravines, the people put out their fires, and the boats hastily seek the harbor." Extinguishing the fires is still a custom, even a law in some parts of Switzerland—in Uri, for instance, which is especially exposed to the violence of the *Foehn*.

CHARLES BUNDY WILSON.
THE UNIVERSITY OF IOWA,
DEPARTMENT OF GERMAN.

THE OPENING OF THE MOUTH AS EXPRESSION.

TO THE EDITOR OF SCIENCE: Charles Darwin ascribed the open mouth in surprise and astonishment to several causes, viz., for quietness and effectiveness of breathing, and by mere relaxation of muscles. It occurs to me that a deeper organic reason may have its force, namely, that the open mouth is attention sign, and is a primitive and constant reaction with the young of many animals for the reception of food—for example, with birds. Any sound or other stimulus immediately causes the young bird to extend its mouth. I have some evidence that with very young infants every stimulus of sound or sight causes opening of the mouth, often in sucking form, and the smile of the infant when the finger is pointed at it may be either nascent or degraded sucking. The common and highly useful tendency of the very young to open the mouth to all stimuli, visual, aural, etc., continues as a survival in after life, being especially brought out with stimuli of high intensity and unusual quality, and thus becomes a mark of surprise and astonishment. It is also noteworthy that with many young boys and girls there is a tendency to open the mouth under any attention. The rise of smiling and laughter as connected with wit and humor—at the basis of which lies surprise—is thus evident as a kind of attention expression. Certainly the primary expression of the mouth is a feeding expression, and that this has been modified and evolved in connection with a variety of attention phenomena seems probable, and it would be worth while to make a very detailed study of expression in infants and young animals with this point in view.

HIRAM M. STANLEY.
LAKE FOREST, ILL., August 8, 1899.

ASTRONOMICAL NOTES.

OBSERVATORY OF YALE UNIVERSITY.

THE annual report of this observatory states that the heliometer has been used for making the final measures of the parallax series of stars having large proper motion. The study of the refraction of highly colored red stars has been continued. The photographic observations of the meteors in November, 1898, gave sixteen trails, eight of which were of Leonids. Four of these were in plates at both of the stations occupied. Dr. Elkin has published in the *Astrophysical Journal* a careful discussion of the position of the radiant obtained from the trails.

FLOWER OBSERVATORY OF THE UNIVERSITY OF PENNSYLVANIA.

VOL. I., Part II., of the publications of this observatory contains the discussion of the zenith telescope observations—October 1, 1896–August 16, 1898. The plan of this work for investigating the variation of latitude is that proposed by Küstner in 1890 and has been most zealously and carefully carried out by Professor Doolittle. The groups of stars, each of which is included in about two hours of right ascen-

sion, are so arranged that one group culminates in the evening and another in the morning hours. The range of the variation in latitude, given in the final corrected results, is 0″.44, and the probable error of a single determination is 0″.134. Two maxima and minima are covered in the period of observations, the range of the maximum and minimum in the middle of the series being somewhat less than the extreme range. Among the interesting details brought out in the critical discussion are: that the value of the micrometer screw is variable from other causes than change of temperature; that the deduced constant of aberration is unexpectedly large, viz., 20″.580, and that the same pairs of stars gave results on different nights which differed occasionally by many times the computed probable error of the observation. No satisfactory explanation of this anomaly has been found. The corresponding anomaly in longitude work is plausibly explained by variation in personal equation of the observers, but it is not easy to apply this explanation to zenith telescope observations.

CHAMBERLIN OBSERVATORY OF THE UNIVERSITY OF DENVER.

Professor Howe continues to make micrometric observations of superior excellence with the Bruce micrometer attached to the 20-inch equatorial. His careful work upon the fainter nebulæ has been embodied in two communications to the Royal Astronomical Society which are published in Monthly Notices, Vol. LVIII., Nos. 6 and 9. The extensive series of observations of Eros from September 12, 1898, to April 6, 1899, is given in the *Astronomical Journal*, No. 463.

ASTRONOMICAL OBJECTIVES.

Zeiss's new catalogue calls attention to the improvements in objectives which have resulted from recent studies encouraged by the varieties of glass manufactured at Jena. The price lists include six or more special combinations having individual excellences. The binary apochromatic lens with ratio of aperture to focal length 1:17 to 1:20 nearly eliminates the secondary spectrum, as does König's combination of one flint and two crown of shorter focus (ratio 1:10 to 1:15) which is styled the triple apochromatic lens. The ordinary silicate glasses are used as heretofore with long focus (ratio 1:15 to 1:18) by Fraunhofer's formula, and there is also a lens of longer focus especially adapted for astrophotographic purposes. Short-focus lenses are represented by a triple lens with ratio 1:4 to 1:6 designed for finders and a binary lens with flat field, both of which have an uncorrected secondary spectrum. It would be interesting to learn how many of these special combinations will come into actual use.

Winslow Upton.

Providence, R. I.,
August 10, 1899.

NOTES ON PHYSICS.

The London *Electrician* states that on July 3d Lord Kelvin sent to the Royal Society the following in a telegram: "An electrified body is set into rotation by the generation of a magnetic field around it. The magneto-optical phenomena discovered by Faraday, Kerr and Zeeman are to be thus explained." In the next issue of the paper a letter from Lord Kelvin states that this announcement was not based on experimental results, but deduced from the current that flows in a metallic conductor at right angles to a growing magnetic field. The telegram is discussed editorially and in a letter by G. F. Fitzgerald. The point seems to be that the growth of the field will cause a displacement of the charge round the body which will be the equivalent of a momentary current, and that this reacting on the field will cause rotation, which, if the body is frictionless, will continue till the stopping of the field produces an equal opposite torque. Fitzgerald states that he has considered this matter, but doubts if the forces will be great enough to permit of experimental demonstration. In the same issue, and in connection with this matter, S. P. Thomson describes and discusses a phenomenon presented to the Royal Society by C. E. S. Phillips, in which a vacuum tube having iron electrodes which can be powerfully energized by an external electromagnet is used. When a discharge has been sent through the tube, and then cut off, even for so long as ten minutes, and then the magnets are energized, a brightly luminous ring forms normal to the field, and

rotates rapidly, the direction of rotation depending upon that of the field, but not of the discharge. This, Thomson explains by electrified molecules passing inward from the walls of the tube and set in rotation by the growing field.

IN the London *Electrician* of July 7th P. A. C. Swinton describes experiments upon the incandescence of Thoria and Ceria as heated by bombardment in a vacuum tube. He states that in the Bunsen flame Thorium oxid and Cerium oxid give about the same degree of incandescence, and that the addition of one per cent. of the latter to the Thorium oxid, as in the Wellsbach mantle, increases the incandescence about eleven times. In the vacuum tube, however, the ceria was but a dull red, when the thoria was at full incandescence, and the same was true of a mixture of half and half; further the addition of the one per cent. of ceria to the thoria increased the incandescence only about five per cent. This seems to favor the theory that chemical action takes place in the action of the Wellsbach mantle. The energy used was about one watt per candle.

F. C. C.

NOTES ON INORGANIC CHEMISTRY.

ATTENTION was recently called to the researches of Armand Gautier on the occurrence of iodin in ocean water. A continuation of his work takes up the iodin in the water of the Mediterranean Sea. The surface water, like that of the Atlantic Ocean, contains no iodids or iodates, but the iodin is present either in microscopic organisms or in complex organic compounds containing also nitrogen and phosphorus and capable of dialysis. The total amount of iodin present is the same for all depths, but varies in its form. Thus at the bottom of the sea iodids and iodates are present to the extent of 0.305 milligrams per liter, while they are zero at the surface. Of iodin in living organisms there is a maximum at the surface and none at the bottom. The soluble organic iodin is more constant, though varying to some extent with a maximum at 880 meters depth. The total iodin present is 2.25 mg. per liter, which is but little less than the 2.40 mg. found in the water of the Atlantic Ocean.

THE same number of the *Comptes Rendus* contains an account of the preliminary work by F. Garrigon on the occurrence of rare metals in water. He finds evidence of the presence of a number of unexpected metals, particularly those of the copper and tin groups. As titanium has been found not only as a constant constituent of almost all soils by Dunnington; but of many, if not all, plants by Wait; and of animals including man — unpublished work of Wait (Univ. of Tenn.), Toole (Wash. & Lee.), and Baskerville (Univ. of N. C.)—it is not unnatural that traces of it should be found in mineral waters.

ONE of the greatest drawbacks to work on the element fluorin has been that the apparatus used must be of platinum or fluor spar. Moissan has, however, now shown that copper vessels can be used even for the electrolysis of hydrofluoric acid, being less attacked than other metals. The cause of this appears to be that there is formed on the surface of the copper a very thin layer of the fluorid of copper, which is wholly insoluble in hydrofluoric acid, and, of course, unattacked by free fluorin.

THREE papers have recently been read before the Chemical Society of London by Harold B. Dixon, which are of considerable interest. The first is on the combustion of carbon bisulfid. He finds it burns in the air with phosphorescence, which, however, begins to appear at 230°, while real ignition does not begin till 232° is reached. Carbon bisulfid is not decomposed by leading through a tube at 400°. It can be detonated by a heavy blow, but the explosion is not propagated through the vapor. The rapidity of explosion is greatest when exactly sufficient oxygen for combustion is present.

A SECOND paper is on the combustion of coal. It is ordinarily accepted that carbon burns directly to carbon dioxid and that this is subsequently reduced by the excess of carbon to carbon monoxid. Professor Dixon finds that when a mixture of air and carbon monoxid is passed slowly over coal at 500° the amount of carbon monoxid is unchanged, but the oxygen disappears completely by union with carbon to form carbon dioxid. On the other hand, if a mixture of 20% carbon monoxid and 80% oxygen is used, and the current is very slow, the

amount of carbon monoxid in the end product is increased. This is interpreted to mean that the primary combustion product at 500° is not exclusively at least carbon dioxid. Dixon is of the opinion that both carbon monoxid and carbon dioxid are formed at 500° and that in each instance there is sufficient heat of formation to occasion a secondary reaction, in the one case with oxygen, in the other with carbon.

THE third paper is on the action of nitrogen monoxid on nitrogen dioxid, in which the conclusion is drawn from experiments that, contrary to the views of Lunge and others that N_2O_3 cannot exist in the gaseous state, NO and NO_2 do unite to a limited degree to an unstable compound, which is the more dissociated the higher the temperature. The reaction $N_2O_3 \gtrless NO + NO_2$ is reversible and the properties of the mixed gases thus accounted for.

IN the same number of the *Proceedings of the Chemical Society* Szarvasy and Messinger describe a new compound of arsenic and tellurium. Proceeding from the fact that the difference in molecular weight of the arsenic compounds of the sixth group, As_2O_3, As_2S_3, As_2Se, is 15–16 units, they calculated that the tellurium compound should have the formula As_8Te_3, and accordingly fused together the components in this proportion under pressure and determined the properties and vapor density of the resulting compound.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

PRESIDENT SCHURMAN, of the Philippine Commission, has returned to the United States.

DR. A. B. MEYER, Director of the Dresden Museums, is now in the United States on a commission from the Saxon government to inspect American museums before the new buildings are erected at Dresden. He is accompanied by Professor P. Wallot, who is one of the international commission of architects selected to decide on the plans of the University of California in accordance with Mrs. Hearst's arrangements.

THE Duke of Bedford has been elected President of the Zoological Society of London, in the room of the late Sir William Flower.

THE Baly gold medal of the Royal College of Physicians, London, awarded for distinguished services to physiology, has been conferred upon Dr. C. S. Sherrington, F.R.S., professor of physiology in University College, Liverpool.

MR. G. A. STONIER, formerly Geographical Surveyer for New South Wales, has been appointed specialist in mining under the Geological Survey of India.

MR. EUSTACE GURNEY, of New College, has been appointed by Oxford University to the University Table at the Naples Biological Station.

AN aid in cryptogamic botany in the Smithsonian Institution, at a salary of $75 a month, will be appointed as a result of a civil service examination to be held on November 5th and 6th.

DR. J. WEINGARTEN, professor of mathematical physics in the Technical School of Berlin, has been elected a foreign member of the Accademia dei Lincei at Rome.

COLONEL HEINRICH HARTL, professor of geography in the University of Vienna, has been made an honorary doctor by the University.

PROFESSOR GUIDO CORA, of Rome, has been elected a member of the Italian Council of Geodesy.

W. D. HUNTER, Assistant Entomologist of the Experiment Station of the University of Nebraska, has been given a month's leave of absence in order to act as Special Agent for the Division of Entomology of the United States Department of Agriculture. He is to investigate the locusts of Minnesota and North Dakota.

AVEN NELSON, Botanist of the Wyoming Station, left Laramie early in June on an extended botanical survey of the Yellowstone National Park and the adjacent forestry reserves. In addition to large collections of the entire flora a careful study of the forage plants and range conditions is contemplated.

WE learn from the *Botanical Gazette* that the botanical plans of the University of Iowa for the summer are as follows: Professor B. Shimek will be engaged in special studies of the forestry problems in Iowa, under the direction of the

U. S. Department of Agriculture; Mr. T. E. Savage will probably complete his studies of the mosses and Hepaticæ of the State; Mr. P. C. Myers will complete a photographic record of the diatoms of Iowa, recent and fossil, and Professor T. H. Macbride will probably spend the summer in the Grand Cañon of the Colorado, studying the forest problems there for report to the United States Department of Agriculture, and incidentally collecting the fungi of the region.

THE Società Bibliografica Italiana has unanimously adopted a resolution declaring that the project of the Committee of the Royal Society of London on an International Catalogue of Scientific Literature is impracticable viewed from the financial standpoint and is open to grave objections from the bibliographic standpoint. The Society has petitioned the Italian government, in view of the new international conference, which is to decide definitely, to add to its official representative technically competent persons who would be in a position to point out the practical and technical difficulties of the present project.

DR. LEO ARONS, privatdocent for physics in the University of Berlin, against whom a complaint was lodged by the Ministry for belonging to the Social Democratic party, has been acquitted by the philosophical faculty of the University.

MR. BEREND BESSEL LORCK, of London, has presented to the Berlin Academy of Sciences a large number of letters addressed to his grandfather, Friedrich Wilhelm Bessel. There are in all 2,946 letters addressed to Bessel by 234 different men of science and artists, including the leading contemporary astronomers. The Academy already possessed 106 letters addressed by Bessel to Struve and now receives 106 letters addressed by Struve to Bessel.

WE learn from *Natural Science* that the Manchester Museum has acquired the Dresser collection of birds. It contains about 10,000 specimens and is especially rich in palearctic specimens.

THE British Medical Association commenced its annual meeting at Portsmouth, on August 1st. The President, Dr. J. Ward Cousins, chose as the subject of his opening address 'The Century's Progress in Medicine and Surgery.' It was reported by the Treasurer that during the year £49,000 had been paid for their new premises on the Strand; the revenue for the year amounted to £42,924.

THE Sixth International Agricultural Congress will be held at Paris from the 1st to the 8th of July, 1900. The sections will be as follows: (1) rural economy (agricultural credit, agricultural associations, land surveying, agrarian questions); (2) agricultural education (experimental stations, field experiments, etc.); (3) agricultural science (application of science to agriculture, agricultural improvements); (4) live stock; (5) practical agriculture (industrial crops and agricultural industries); (6) special crops of the south (silk production, early fruit and vegetables, perfume plants and colonial productions); (7) injurious insects and parasites (international measures for the protection of useful animals).

A CORRESPONDENT has sent us this proposed inscription for the statue of Darwin: "Charles Darwin, the great naturalist, whose book on the 'Origin of Species' revolutionized the course of human thought. His carefulness in investigation was only equalled by his genius, and only surpassed by his uprightness of character." It is also suggested that the best inscription would be simply 'Charles Darwin.'

THE Natural History Museum, London, has set aside one of the alcoves in the Central Hall for the exhibition of specimens recently acquired. According to *Natural Science* the following have been on view: Fish, mollusca and other invertebrata, from Lake Tanganyika, collected by Mr. J E. S. Moore, illustrating the marine origin of the fauna and its antique character. Fish from the River Congo, described by Mr. Boulenger (*Annales Mus. Congo*), and presented by the Secretary of State of the Congo Free State. *Lepidosiren paradoxa*, collected in the Paraguayan Chaco by Mr. J. Graham Kerr. A collection of rare birds from Patagonia and Argentina, presented by Dr. F.P. Moreno, Director of the La Plata Museum. A fine collection of Hexactinellid sponges from Japan. A male

Cervus sica manchuricus in full summer coat—a splendid specimen, presented by the Duke of Bedford. And a large specimen of the Tarpon fish, *Megalops thrissoides*, captured off Florida by Mr. Otis A. Mygatt, and presented by H.R.H. the Prince of Wales.

UNIVERSITY AND EDUCATIONAL NEWS.

We are informed that the following doctorates were conferred last year in addition to those published in the issue of August 4th. At Northwestern University, Mr. Charles Hill was given the degree of Doctor of Philosophy with a thesis entitled 'Developmental History of the Primary Segments of the Vertebrate Head,' and at the University of Minnesota, Mr. Francis Ramaley, now professor of biology in the University of Colorado, was given the degree for work in plant morphology.

The two veterinary colleges situated in New York City have been consolidated under the name of the New York American Veterinary College and School, and this has been made a part of the New York University. Dr. A. F. Liantard has been appointed Dean.

Two fellowships in pathology have been established in McGill University. They are of the value of $500 per annum, and the holders may be required to assist in directing laboratory work to the extent of 12 hours a week.

The reorganization and separation of the faculties of the two Colleges, 'Letters' and 'Industrial,' hitherto constituting the 'General Faculty' of the University of Nebraska,' has been referred to a committee consisting of the Deans of the Colleges and the Acting Chancellor of the University, to report to the Regents at the semi-annual meeting in December. Dr. Ellery W. Davis has been appointed Chairman of the Industrial College Faculty and Acting Dean of the Industrial College.

At a recent meeting of the Regents of the University of Nebraska bids were accepted for the erection of an Experiment Station building for $21,332 and a power plant for $2,947. Provision has also been made for certain chemical work in the sugar beet experiments in progress at Ames, Nebraska.

The Council of the University of Paris has fixed the fees for those studying for the doctorate as follows: Annual matriculation, 20 fr.; library, 10 fr.; fees for laboratories, 200–800 fr.; examination, 140 fr.

Professor Henry G. Jesup, since 1877 professor of botany in Dartmouth College, has resigned.

Dr. August L. Rimbach (Ph.D., Jena, 1887), of Jena, Germany, has been appointed instructor in vegetable physiology and pathology in the University of Nebraska, He was professor of botany and zoology in the University of Cuenca, Ecuador, from 1889 to 1894, after which he spent nearly two years in botanical travel in the Andes and along the Pacific coast of tropical South America. More recently he has given his time to botanical researches in Germany. These have been chiefly physiological and ecological, and the results have appeared in numerous papers in the German botanical journals.

Professor E. A. Burnett, of the Agricultural College of South Dakota, has accepted the chair of animal husbandry in the University of Nebraska, and will resume the duties of his new position at the opening of the fall semester. Mr. Abel A. Hunter has been appointed botanical collector for the University.

Mr. H. G. Timberlake, of the University of Michigan, has been appointed instructor in botany in the University of Wisconsin, and Mr. G. T. Moore, of Harvard University, has received a similar appointment at Dartmouth College.

Dr. E. H. Starling, F.R.S., has been elected to the Jodrell professorship of physiology in the University of London, in succession to Professor Schäfer, who, as we have already stated, has accepted a call to Edinburgh.

Dr. Sutherland, assistant professor of pathology at Glasgow, has been appointed professor of pathology at St. Andrews, in the place of Professor Muir, recently appointed professor of pathology at Glasgow.